

Sustainable solution for urban environment: Miyawaki Forest

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Abstract— Rapid urbanization, population growth and rural-to-urban migration, especially in fast-developing economies (such as India and China) have resulted in a fast decline in forest cover and green space in a large number of urban centers around the world. Recent reports suggest that Delhi, India’s capital, has a green cover of only 20.6% and has a declining trend of dense and very-dense forests. In fact, India ranks one of the highest among the large countries in terms of reduction in tree cover extent. This is an alarming situation and does not bode well for human health and ecosystem, in general. Immediate and long-lasting steps are needed to check the diminishing green cover in most of the metropolitan cities of the world.

Among a number of ideas suggested for checking the rapid decline in the green cover; the concept of Miyawaki forest offers a unique solution. Developed by the famous Japanese botanist, Akira Miyawaki, the Miyawaki forest is an affordable, low-tech, maintenance-free and rapid method of growing native vegetation on degraded lands (Fig. 1). Such forests can be grown by anybody using simple methods and a lush-green forest consisting of native vegetation in about an year’s time is expected. A number of industries and cities have successfully grown Miyawaki forests for enhancing the tree cover and a better environment.



Figure 1. Changes in landscape due to the growth of Miyawaki forest, pre and post-growth scenario

Miyawaki forests have also been successfully tried in India and several start-ups offer help to individuals and organizations in growing Miyawaki forest on their land. However, large-scale deployment of this technology for improving the declining air quality is yet to be attempted. The current work discusses the concept of Miyawaki forest, its advantages and possibilities of its utilization at large-scale in India. Potential issues in its deployment and solutions thereof are also presented. A competing technology, vertical gardens, is also briefly discussed for comparison. It is expected that Miyawaki forests will be able to reverse the declining tree cover, provide a better environment and improve our air quality.

Keywords— Miyawaki Forest, Sustainable, Urban Environment, Air quality, Health

INTRODUCTION

Rapid degradation of urban environment is a common scenario in rapidly developing economies, leaving the residents gasping for a breath of clean air. Delhi, India is a prime example of this and experiences only a handful of days each year that can be termed to have good air quality. The exploitation of vegetated fields for urbanization has caused a steep decline in the green cover of not only Delhi, but most of the other major Indian cities as well. The resulting health issues and environmental degradation requires rapid solutions, without compromising the economic growth and infrastructural development.

Unfortunately, the growth of trees and forests is a relatively slow process; while the need of the hour is relatively rapid solutions. Conventional forests may take decades to centuries to grow, that too assisted by numerous factors (including, but not limited to, environmental conditions, little or no human interferences, etc.). However, the cities are running out of time to provide cleaner air to their residents. The restoration of degraded lands is an urgent necessity in urban settings. An innovative and (relatively) rapid method of land restoration is Miyawaki forests [1], named after Dr. Akira Miyawaki (a Japanese botanist). This method has been used to restore forests and green cover at hundreds of locations throughout Japan. In addition, it has shown promising results in other parts of Asia, including Thailand, Malaysia and India.

This approach is based on identifying and growing native species in a given region. Non-native plant species, generally introduced for providing green cover and other purposes, have more stringent nutrient and environmental requirements. And, hence such species require more care, resources, and have a slower growth rate. Native species are already accustomed to the local soil and environmental conditions and hence stand a better chance of growth and that too a rapid one. The Miyawaki method makes use of this key advantage of native vegetation. It is important to provide conservation planner for the conservation of biology [2].

The technique supports the growth of a dense, mixed, native forest and results in a native forest ecosystem, complete with small animals, rodents, birds, etc. The natural selection, resulting from the competition between different types of native species, creates a diversified natural forest. The method supports the growth of primarily canopy trees. In order to match a natural forest system, random plantation of different types of native seedlings (with extensive root system) are randomly planted. Growth rates of a meter per year or higher are generally observed, ultimately resulting in a complete, mixed, native forest ecosystem in a span of few years, instead of decades (to centuries) needed by other systems of planting. There is another study also which is based on the relationship of the major forest types to the forests of the adjacent Korean Peninsula, Northern China and Russia Far East [3].

The ability of plants to consume carbon dioxide and produce oxygen, during the process of photosynthesis, is generally considered the best deterrent to global warming. And Miyawaki forests have the potential to act as carbon-sinks in our cities and minimize the global warming [4].

Despite its obvious advantages, the method has its share of disadvantages and is yet to be upscaled to really large-scale land restoration projects. The method has been shown to work well in Indian settings, however, vertical gardens (a competing approach) has received more traction in Delhi. This technique has been described briefly as well. The current work is aimed at providing a brief review of the Miyawaki forests technique, its advantages, disadvantages and possible ways to overcome them.

1. Air Pollution Issues and Health Effects in Urban Settings

According to the study of World Health Organization, the World is becoming hotter, as it gets more crowded. Engines continue to pump out dirty emissions and half of the World has no access to clean fuels or technologies. Air is growing dangerously polluted that we breathe in. Out of ten, nine people now breathe polluted air. Air pollution has a number of different emissions sources, but the major contributors are motor vehicles and industrial processes [5]. Ambient air pollution can have adverse effects on the health of exposed population [6]. Exposures to pollutants such as airborne particulate matter and ozone has been associated with increases in hospitals admission also. Effects are found in short-term studies [7]. It is estimated that particles pollutants cause more than 500,000 deaths annually [8]. Mortality and morbidity were estimated the impact of outdoor and traffic-related air pollution on public health in Austria, France and Switzerland [9]. Combustion of fossil fuels is responsible for the progressive change in the atmospheric composition [10].

Many health effects also arise from air pollution like death from stroke, lung cancer and heart diseases. It is difficult to escape air pollution from the environment, no matter if you are living in the posh area. According to the study, it has been shown that exposure to the natural environment has an independent effect on health and healthy related behaviour [11].

Microscopic pollutants can penetrate deep into our respiratory and circulatory system. It damages our lungs, heart and brain. In atmospheric science, the new focus is on the impact of global air pollution on climate and the environment [12]. Few countries have some of the highest particulate matter level in the world. China is one of them. Objective of the study was to examine the association of particulate matter with an aerodynamics diameter of less than $10\mu\text{m}$ (PM_{10}) [13].

The lack of visibility clearly indicates that air is not healthy. Across the world, toxic pollutants are seen in the air and it exceeds average annual values recommended by WHO air quality guidelines. There are two types of air pollution-ambient air pollution or outdoor pollution and household or indoor pollution. According to the study, household air pollution kills 4 million people in a year and tends to affect countries in Africa and Asia, where polluting fuels and technologies are used every day particularly at home for cooking, heating and lighting. Women and children who tend to spend more time indoors, are affected the most. It also causes long term environmental damage and it is a major threat to health and well-being.

Planting trees is a cost-effective way to tackle urban air pollution, which is growing problems for many cities. According to the study of UN based, The Nature Conservancy (TNC) reported the average reduction of particulate matter near trees was between 7% and 24% while the cooling effect is 2 degree Celsius. Lead author Rob McDonald said that trees were already providing a lot of benefits to people living in urban areas. According the WHO Health Statistics 2016, air pollution is caused by inefficient energy production, distribution, and use especially in the industrial, transportation and building sectors and by poor waste management system.

Dr. McDonald observed, there is no other replacement of trees, only trees can help in order to clean the air [14].

One of the pillars of the Miyawaki forest technique is the identification of native vegetation species. For this purpose, a detailed field survey is needed to determine the type of vegetation. The field survey is coupled with the phytosociological survey and environmental description. It is important to investigate basic soil characteristics, light condition, effect of environmental factors on the survival of seedlings grown in three degraded vegetation [15]. The vegetation units in the surrounding region is studied and classified as either native or substitute vegetation (PNV) [16]. This data is then compared with the actual vegetation at the site of interest and potential natural vegetation are identified for restoration purposes. The potential natural vegetation consists of each unit of species combinations. Such detailed studies provide the knowledge of potential major tree species of the native plant communities of that region [17].

Once the potential natural vegetation is identified, their seeds are collected and germinated. These are allowed to grow in pots till their root systems are fully developed. This overcomes the difficulties associated with transplantation of bare seedlings of natural vegetation. The potted seedlings are then mixed with similar seedlings of other natural vegetation species and these are planted in a dense, yet random manner. This is done to ensure a true natural vegetation. The degraded land may have to be prepared by mulching with rice straw and similar organic materials (of agricultural origins) to minimize the soil dryness. The other advantages include prevention of soil erosion (especially on steep slopes and under extreme precipitation events), protection against cold and fertilization potential of the organic materials used. In the initial growth phase, weeding may be needed once or twice in first couple of years. The weeded grass is an additional source of mulch. Over time, natural selection takes over and a dense, mixed, native forest is resulted [18].

2. Outcomes and Indian Scenario

The first successful implementation of the Miyawaki technique took place in Nippon Steel Corporation, Oita, Japan in the 1970's. Since then over 1300 sites in Japan have benefitted from this approach. Apart from the Asian countries (including, Malaysia and Thailand), Italy and Chile have also had success with this method. The outcomes include dense native forests, complete with native fauna including, birds, insects, squirrels, etc. Growth rates of about one meter per year have been reported in a number of sites [19].

In India, the technique has been used at few sites and is gaining popularity. A number of startups are working to promote this method and make it affordable to the interested individuals and/or organizations. These include, Digital Green, Waste Ventures, Banyan Nation, Saytrees, etc.

Another way of doing planation is vertical gardening. Greater Chennai Corporation planning to set up a vertical garden on flyovers, skyways, causeways and bridges. Generally, those species are mostly found in vertical gardening which can absorb heat and dust. Treated water from sewage treatment plant will use to maintain these gardens [20]. Inspiration is being drawn from China and Italy's vertical forests. Noida also has started setting up vertical gardens to raise the aesthetics of the city and to reduce the pollution [21]. North and South Delhi Municipal Corporations are planning vertical gardens at Delhi's school, markets and historical structures.

These will help in neutralizing the pollution which is caused by dust and vehicular emissions [22]. A competing technique, vertical gardens, has gained a lot of attention in Delhi. This is a relatively flexible and highly productive system (Fig. 2). In this system, gardening is done on a vertical surface than on a horizontal surface [23]. It has various advantages like it takes less space, is easier to harvest and maintain. In this method, the plants are easier to reach for fertilizing, watering and harvesting in convenient manner. It provides improved air circulation by putting plants in a vertical configuration. It saves plants from damage due to pets or wild animals by keeping them out of their reach. Such gardens can be easily developed in congested areas and traffic intersections. Additional advantages of vertical gardens include, temperature regulation, shade, improvement in air quality by absorption of pollutants (including volatile organic compounds, etc.) [24]. Delhi government has recently planted lakhs of plants in vertical gardens situated on pillars of metro lines and elevated roads. Such system is being used to beautify the city as well as provide some much-needed greenery at busy areas.



Fig. 2 Vertical Garden

3. Advantages and Disadvantages of Miyawaki Forests

The advantages of Miyawaki forests include, rapid restoration of land, development of an entire ecosystem (instead of just plants), much faster development of greenery as compared to conventional forests, minimal maintenance and care, low-cost, etc. The disadvantages include, the necessity to carry out detailed field surveys (in case, potential native vegetation is not known), requirement of a tract of land (unlike vertical gardens), high cost in the initial phase (for land preparation, survey, planting, etc.) and a rather monotonous appearance due to trees being of relatively same age.

I. CONCLUSION

Forests are a human necessity for their ability to supply oxygen, act as carbon-sink, provision of shade, food, wood, among others. Yet, human greed has resulted in a steep loss of forest cover in many cities around the country. This has not only led to loss of trees, but soil erosion and land degradation as well. The cities are in a dire need of forests and greenery to ensure adequate air quality. Miyawaki forests, a technique that supports the growth of native vegetation, with low maintenance needs, is a promising solution. The method has shown tremendous success in Japan and some other parts of Asia as well. However, it is yet to find major traction in India. Governmental support, increased awareness and participation of NGOs and other organizations is needed to ensure the revival of our degraded lands and lost forests. It is expected that Miyawaki forests will help increase the forest cover in our country and provide a greener and better environment to our current and future generations.

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